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FLUORSPAR AND CRYOLITE IN 1926

By HUBERT W. DAVIS

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FLUORSPAR AND CRYOLITE

By HUBERT W. DAVIS

FLUORSPAR

Fluorspar, or fluorite, is a nonmetallic crystalline mineral that usually occurs in glassy transparent isometric crystals, largely cubic, or in cleavable masses. Less commonly it has a granular or fibrous structure, and occasionally it is banded. Fluorspar has a specific gravity of 3.2, is brittle, has a hardness of 4, and can easily be scratched with a knife. Fluorspar is a mineral of many colors, ranging from clear, colorless, or slightly bluish, and glasslike through various striking hues, of which purple and green are most common; much of it is white and opaque. Chemically it consists of calcium and fluorine in the proportion of 51.1 to 48.9.

FLUORSPAR PRODUCED AND SHIPPED

The steel industry, the largest user of fluorspar, made a record output; the fluorspar producers did a larger volume of business in 1926 than in 1925. The increase in shipments of fluorspar from domestic mines, however, did not keep pace with the increase in imports of fluorspar, which were the largest on record.

Shipments of domestic fluorspar to steel plants were 15 per cent more than in 1925, and those to manufacturers of glass and enamel showed increases of 11 and 5 per cent, respectively. The exports, though small, were twice as large as in 1925 and are the largest recorded since 1922. The demand for domestic fluorspar by chemical manufacturers was about 23 per cent less than in the preceding year, and the shipments to foundries were about the same as in 1925.

In 1926 shipments of fluorspar from domestic mines aggregated 128,657 short tons, valued at \$2,341,277, or an increase of 13 per cent in quantity and of 14 per cent in total value compared with 1925. The general average value per ton f. o. b. mines or shipping points for all grades in 1926 was \$18.20, which is 14 cents higher than the average in 1925. The general average value of the fluorspar shipped to steel plants in 1926 from the Illinois-Kentucky district was \$16.98 a ton and from the Colorado-New Mexico district \$12.69 a ton. This difference in average values does not necessarily represent differences in quality of fluorspar from these two districts, but differences in freight costs from the mines to consuming centers.

The table that follows presents such details of the shipments of fluorspar for 1923 to 1926, by States, as may be published without revealing, except by permission, the statistics of individual producers.

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Fluorspar shipped from mines in the United States, 1923-1926

State	Gravel			Lump			Ground			Total		
	Short tons	Value		Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average		Total	Average		Total	Average		Total	Average
1923	Colorado	3,957	\$36,631	\$9.26	2,087	\$23,079	\$11.06	7,137		6,044	\$59,710	\$9.88
	Illinois	52,249	1,013,927	19.41	3,659			3,615	\$36.86	65,045	1,443,490	22.19
	Kentucky	30,394	756,701	19.21	2,432	232,846	26.37	50		45,441	945,402	20.81
	New Mexico	3,540	38,161	10.78	738					4,328	50,861	11.75
	New Hampshire				142	3,160	22.25			142	3,160	22.25
1924	Utah				188	3,196	17.00			188	3,196	17.00
		99,140	1,845,420	18.61	11,246	262,281	23.32	10,802	36.86	121,188	2,505,819	20.68
	Colorado	11,986	130,791	10.91	315	4,620	14.67			12,301	135,411	11.01
	Illinois	54,541	1,042,089	19.11	2,766			4,760		62,067	1,288,310	20.76
	Kentucky	41,809	789,352	18.88	932	108,090	22.68	5,106	35.89	47,847	988,940	20.67
1925	New Mexico	1,620	19,318	11.92	883			77		2,580	35,178	13.63
	Utah				184					184	3,292	17.89
		109,956	1,981,550	18.02	5,080	112,710	22.19	9,943	35.89	124,979	2,451,131	19.61
	Colorado	10,560	137,343	13.01	1,216	16,364	13.46			11,776	153,707	13.05
	Illinois	46,195	783,451	16.96	3,366			4,867		54,428	1,024,516	18.82
1926	Kentucky	39,153	669,672	17.10	1,176	115,814	21.13	4,497	32.25	44,826	833,794	18.60
	New Mexico	1,487	20,817	14.00	939			213		2,639	40,325	15.28
		97,395	1,611,283	16.54	6,697	132,178	19.74	9,577	32.25	113,669	2,052,342	18.06
	Illinois	47,254	812,129	17.19	1,780			4,700		53,734	1,012,879	18.85
	Kentucky	53,386	912,525	17.09	2,641	108,710	20.54	6,467	32.26	62,494	1,167,129	18.68
Colorado		1,063	144,200	12.59	820			106		1,989	161,269	12.98
		10,389			51					10,440		
		112,092	1,868,854	16.67	5,292	108,710	20.54	11,273	32.26	128,657	2,341,277	18.20

HISTORY OF PRODUCTION

The accompanying table presents statistics of the production of fluorspar in different States beginning with 1880. The record of production prior to 1880 was not obtained, and the statistics for Kentucky and Colorado are incomplete for certain years after 1880, so that more fluorspar has been mined than the table shows. The unrecorded output must be small, however, as the advantages of fluorspar over limestone as a flux in basic open-hearth steel plants have been generally recognized only since about 1899. Before that time fluorspar was used mainly in the preparation of hydrofluoric acid and in the manufacture of opalescent glass; consequently the demand was small.

The production of fluorspar by years for 1880 to 1904, a brief discussion of the history of mining in the different States, and estimates of unrecorded output in early years are given in Mineral Resources for 1925, pp. 9 to 14.

Fluorspar produced ¹ in the United States, 1880-1926, by States

Year	Arizona		Colorado		Illinois		Kentucky		Nevada		New Hampshire		New Mexico		Tennessee		Utah		Washington		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1880-1904	654	\$6,593			169,870	\$1,037,399	134,186	\$710,467							400	\$3,400					305,110	\$1,787,859
1905			1,156	\$8,200	33,275	220,206	22,694	132,362							260	1,720					57,385	362,488
1906			300	1,800	28,268	160,623	11,868	79,802							360	1,800					40,796	244,025
1907			3,300	11,400	25,128	141,971	21,058	133,971													49,486	287,342
1908	34	252	701	4,266	31,727	172,838	6,323	48,642													38,785	225,998
1909	30	435	350	2,100	41,852	232,251	7,800	53,233					710	\$3,728							50,742	291,747
1910			268	1,608	47,302	277,764	17,003	124,574					4,854	26,250							69,427	430,196
1911			721	4,226	68,817	481,635	12,403	96,574			800	\$6,400	4,307	22,612							87,048	611,447
1912			1,639	9,834	103,937	695,457	10,473	61,186			300	1,500	1,196	1,176							116,545	769,163
1913	100	800	4,432	26,592	85,854	550,815	19,622	113,903			200	1,200	5,372	42,976							115,580	736,286
1914			1,978	12,992	73,811	426,063	19,077	128,986			250	2,000									95,116	570,041
1915			247	1,482	116,340	624,040	19,219	129,873			650	5,200	485	3,880							136,941	764,475
1916	199	2,587	8,669	42,457	126,369	746,150	19,698	123,596			800	7,864									155,735	922,654
1917	135	1,080	17,104	196,633	156,676	1,373,333	43,639	697,566			1,274	19,110									218,828	2,287,722
1918	364	5,537	38,475	416,780	132,798	2,887,099	87,604	2,069,185			1,059	21,243	3,437	64,348			20	\$465	60	\$824	263,817	5,465,481
1919	45	450	9,687	150,739	92,729	2,430,361	32,386	883,171	400	\$5,600	531	12,826	2,346	37,643			166	4,784			138,290	3,525,574
1920	181	3,264	12,852	251,308	120,299	3,096,767	46,091	1,246,942	532	8,672	202	4,040	6,353	101,460			268	6,094			186,778	4,718,547
1921			3,143	39,907	12,477	315,767	15,266	294,513			567	13,721	3,507	60,186							34,960	724,094
1922			2,309	20,169	83,855	1,493,188	52,484	970,059			690	15,353	2,180	30,992			78	1,404			141,596	2,531,165
1923			6,044	59,710	65,045	1,443,490	45,441	945,402			142	3,160	4,328	50,861			188	3,196			121,188	2,505,819
1924			12,301	135,411	62,067	1,288,310	47,847	988,940					2,580	35,178			184	3,292			124,979	2,451,131
1925			11,776	153,707	54,428	1,024,516	44,826	833,794					2,639	40,325							113,669	2,052,342
1926			10,440	2 161,269	53,734	1,012,879	62,494	1,167,129					1,989	(2)							128,657	2,341,277
	1,742	20,998	147,892	2 1,712,590	1,786,658	22,132,932	799,502	12,063,870	932	14,272	7,465	113,617	45,283	2521,615	1,020	6,920	904	19,235	60	824	2,791	458,36,606,873

¹ Beginning with 1906 figures represent shipments from mines.

² Value for New Mexico for 1926 included with Colorado.

SHIPMENTS, BY USES

The table that follows shows the relative dependence of the fluorspar industry on the different industries in which fluorspar is used. The predominance of the steel industry as a purchaser of fluorspar is evident. The high value of fluorspar for hydrofluoric acid, glass, and enamel and sanitary ware is due to the high quality demanded.

Fluorspar shipped from mines in the United States, 1925-26, by uses

Use	1925				1926			
	Per-cent-age	Short tons	Value		Per-cent-age	Short tons	Value	
			Total	Aver-age			Total	Aver-age
Steel.....	80.73	91,760	\$1,482,461	\$16.16	82.09	105,614	\$1,744,085	\$16.51
Foundry.....	5.52	6,275	121,177	19.31	4.83	6,212	121,453	19.55
Glass.....	5.95	6,767	211,331	31.23	5.83	7,507	240,288	32.01
Enamel and sanitary ware.....	2.85	3,237	101,060	31.22	2.65	3,410	113,445	33.27
Hydrofluoric acid (including fluorspar used in manufacture of aluminum and refining of lead).....	3.92	4,455	114,059	25.60	2.65	3,410	79,105	23.20
Miscellaneous.....	.10	120	4,680	39.00	.29	372	7,986	21.47
Exported.....	99.07	112,614	2,034,768	18.07	98.34	126,525	2,306,362	18.23
	.93	1,055	17,574	16.66	1.66	2,132	34,915	16.38
	100.00	113,669	2,052,342	18.06	100.00	128,657	2,341,277	18.20

In 1926 fluorspar was produced in four States—Colorado, Illinois, Kentucky, and New Mexico—of these only Kentucky showed an increase.

The production of crude fluorspar in 1926 is estimated at 245,253 short tons, which is equivalent to 133,077 tons of merchantable fluorspar. The quantity of crude fluorspar treated in 1926 was 242,674 short tons, from which was recovered 130,918 tons of merchantable fluorspar. Thus, for each ton of merchantable fluorspar recovered in 1926, 1.85 tons of crude fluorspar was handled.

Fluorspar-bearing rock mined in 1926, by States, in short tons

State	Mines and prospects worked	Fluorspar-bearing rock mined	Merchantable fluorspar equivalent
Illinois.....	9	84,575	50,053
Kentucky.....	36	133,203	70,585
Colorado and New Mexico.....	6	27,475	12,439
	51	245,253	133,077

Fluorspar-bearing rock treated and merchantable fluorspar recovered in 1926, by States where mined, in short tons

State	Fluorspar-bearing rock treated	Merchantable fluorspar recovered	Ratio of treated rock to fluorspar recovered
Illinois.....	92,291	55,088	1.675
Kentucky.....	123,467	63,616	1.941
Colorado and New Mexico.....	26,916	12,214	2.204
	242,674	130,918	1.854

FLUORSPAR INDUSTRY IN 1926, BY STATES

COLORADO

The shipments of fluorspar from Colorado mines in 1926 amounted to 10,440 short tons, a decrease of 11 per cent from 1925. Of these shipments 10,054 tons was sold for use in steel plants, 385 tons for use in foundries, and 1 ton was sold for unknown use.

In 1926, as in 1925, the Wagon Wheel Gap mine, $1\frac{1}{4}$ miles southwest of Wagon Wheel Gap, in Mineral County, was the largest producer of fluorspar in Colorado. About 44 per cent of the shipments from this mine in 1926 went to the steel works at Pueblo, Colo., and the remainder, 56 per cent, went to consumers in the mid-west and on the Pacific coast.

The only mine in Jackson County from which fluorspar is produced is about 3 miles northwest of Northgate. It was worked about two and one-half months in 1926, during which time development work was carried on and an additional stope was opened for production. The fluorspar produced at this mine in 1926 was of fluxing grade and was shipped to mid-west markets.

During 1926 some fluorspar of fluxing grade was produced in the Jamestown district, in Boulder County; all of it was treated at the Lehman mill, whence it was shipped to a mid-west consumer.

The names and addresses of shippers of fluorspar from Colorado in 1926 are given below:

Shippers of fluorspar from Colorado in 1926

Colorado Fluorspar Corporation-----	Cowdrey, Colo.
Colorado Fuel & Iron Co-----	Denver, Colo.
E. W. Lehman-----	Jamestown, Colo.

ILLINOIS

In 1926 the quantity of crude fluorspar milled in Illinois aggregated 92,291 short tons, from which was recovered 55,088 tons of merchantable fluorspar, a loss in treating of 37,203 tons and a ratio of 1.675:1. In 1926 shipments of fluorspar from Illinois amounted to 53,734 short tons, or a decrease of about 1 per cent; they were reported distributed among the various industries as follows:

Distribution among the various industries of fluorspar from Illinois in 1926

Industry:	Short tons
Steel-----	45,328
Foundry-----	1,854
Glass-----	3,009
Enamel-----	1,591
Hydrofluoric acid-----	1,501
Miscellaneous-----	371
Exported-----	80
	<hr/> 53,734

In 1926, as in 1925, the Daisy mine was the largest producer of fluorspar in Illinois. The output of this mine was supplemented by considerable fluorspar from the Empire mine, which is worked under lease by the operators of the Daisy mine. Exploration and development work conducted during the year at the Daisy mine and north

of it was reported as satisfactory, maintaining ore reserves well ahead of mining. Two hydraulic classifiers, 6 drag dewatering machines, and 6 concentrating tables were added to the Rosiclare mill, at which the ore from the Daisy and Empire mines is treated. This improvement has increased mill efficiency considerably and has given better separation of fluorspar and gangue and a better quality of concentrate. The mill equipment, which was formerly supplied with direct current, is being converted to use alternating current. At the Daisy mine alternating current was substituted for direct during 1926.

During 1926 the Franklin Fluorspar Co. did no actual mining of fluorspar at its Illinois mines, although some crude fluorspar was recovered in cleaning up the mines. Its mill, however, was operated during the year, treating stock pile and purchased fluorspar and mill tailings. This company is reported to have done some experimental work on the flotation of fluorspar. In 1926 it sold 6,400 ounces of fluorspar for use in the manufacture of optical instruments.

The Hillside mine, on the eastern extension of the Rosiclare vein, was worked on a considerably increased scale during 1926. A new body of fluorspar was reported developed.

At the Spar Mountain mine, located about 5 miles northeast of Cave in Rock, Ill., considerable important development work was reported done in 1926, resulting in materially increasing the existing reserves. The mill in which the fluorspar from this mine is treated is situated at Cave in Rock, from which the finished fluorspar is transported about 25 miles up the Ohio River to Shawneetown, Ill., whence it is transferred to railroad cars and shipped to consumers. A large quantity of fluorspar was shipped from this mine in 1926.

Some fluorspar was mined at the Dimick and Patrick mines, near Rosiclare, Ill., and was sold to the Franklin mill.

A deposit of fluorspar on the Knight property in Pope County was being developed during 1926, in the course of which a small quantity of fluorspar was mined but not sold.

Some development work was done in 1926 at the Lead Hill mine, about 4 miles northeast of Cave in Rock, and some fluorspar was mined and shipped.

A list of producers of fluorspar in Illinois in 1926, with their post-office addresses, follows:

Producers of fluorspar in Illinois in 1926

Basic Mineral Co.....	Pittsburgh, Pa.
Benzon Fluorspar Co.....	Cave in Rock, Ill.
Dimick, W. E.....	Rosiclare, Ill.
Douglas Fluorspar Mines Co.....	Karbers Ridge, Ill.
Franklin Fluorspar Co.....	Paducah, Ky.
Hillside Fluor Spar Mines.....	Chicago, Ill.
Knight, E. A. and A. D.....	Rosiclare, Ill.
Rosiclare Lead & Fluorspar Mining Co.....	Cleveland, Ohio.
Troutman, W. E.....	Rosiclare, Ill.

KENTUCKY

The quantity of crude fluorspar treated in Kentucky in 1926 was 123,467 short tons, from which was recovered 63,616 tons of merchantable fluorspar, a loss in milling of 59,851 tons and a ratio of 1.941:1.

The shipments of fluorspar from Kentucky in 1926 amounted to 62,494 short tons, an increase of 39 per cent over 1925. They were the second largest ever recorded for that State, and for the second time since 1904 they exceeded those of Illinois. The shipments of fluorspar from Kentucky in 1926 were distributed among the industries as follows:

Distribution among the various industries of fluorspar from Kentucky in 1926

Industry:	Short tons
Steel -----	48, 774
Foundry -----	3, 548
Glass -----	4, 498
Enamel -----	1, 743
Hydrofluoric acid -----	1, 879
Exported -----	2, 052
	<hr/> 62, 494

In 1926 much activity in the development of bodies of fluorspar was reported in Caldwell County, Ky. The deposits in this county occur east and southeast of Fredonia and north and northwest of Princeton. At the Marble property, about 4 miles east of Fredonia, where fluorspar is reported to have been first mined in Caldwell County, development work was begun in July, 1926, and continued with satisfactory results until November 1. The present operators have located about 500 feet from the old workings, and report that they have found in virgin ground a shoot of fluorspar which appears to be larger and better than that at the old workings. Some fluorspar was found within 5 feet of the surface. The shaft has been sunk 50 feet and a 135-foot level has been driven in ore 3 to 5 feet wide. This new work has developed a large supply of fluorspar. Development work was reported in progress on an adjoining property, to which the same vein extends.

A fluorspar property $2\frac{1}{2}$ miles from Crider, in Caldwell County, which was being developed in 1925 by the Princeton Spar Co., was leased on February 12, 1926, to the Pigmy Corporation, which conducted mining operations on a small scale.

A small quantity of fluorspar mined from a deposit near Princeton was shipped to Marion, Ky., where it was treated in the mill of the Kentucky Fluorspar Co.

The Watson (or Liberty Bond) mine, 7 miles southwest of Marion, was operated on a much enlarged scale during 1926. About one-fifth of the product from this mine was shipped for use in the manufacture of hydrofluoric acid and the remainder was sold to the Franklin and Kentucky mills at Marion.

In 1926 the Franklin Fluorspar Co. handled the output of its own mines—the Susie Beeler, Mary Belle, Memphis, Brown, Ada Florence, Beard, Loveless, Cross, and Tyner mines, which are 5 to 15 miles from Marion, and the Haffaw mine, situated about 1 mile from Mexico, Ky.—and to meet requirements purchased considerable fluorspar from the Watson, Butler, Summers, Davenport, Holly, and other mines. This company has well-equipped mills located at Marion and Mexico, where the fluorspar from its own mines and that purchased is prepared for the market. The Loveless and Cross (or Ebbie Hodge) mines were purchased by the Franklin

Fluorspar Co. in 1926; and the Manley and Tyner mines were leased for 5 and 10 years, respectively.

The Lucile mine was one of the important producers of fluorspar in the Kentucky district in 1926. This mine is a short distance south of the railroad station at Marion and is of particular interest because of its remoteness from other productive mines, the nearest being about 5 miles. Operations at the Lucile mine were suspended about 1922 as the vein seemed to be exhausted, but a cave-in in the old workings later showed a little fluorspar, which upon being traced revealed a large body. From October 15, 1925, to December 31, 1926, this vein has yielded about 5,700 tons of crude fluorspar. The fluorspar from this mine is treated in the Kentucky mill, which is adjacent to the mine, on a tonnage basis for the producer.

During 1926 development work, including the sinking of a shaft from the 170-foot level to the 270-foot level and crosscutting to and drifting on the vein, was done at the Lafayette mines, near Mexico, Ky. Mining operations included both development of virgin fluorspar bodies and recovery of fluorspar remaining in old workings of former operators. During the year the concentrating plant, which is connected with the mines by a narrow-gauge railroad, was enlarged and revised to increase the capacity of fluorspar production and to improve the recovery of lead and zinc. An engine house and a headframe for the new shaft were installed, two employees' residences and minor surface construction were completed, and the water-supply reservoir for the mill was enlarged.

The Blue & Marble mine, about 1 mile south of Mexico, Ky., shipped about one-fourth less fluorspar than in 1925.

The Holly mine, about 10 miles west of Marion, Ky., was worked on an increased scale in 1926.

The Independent mine, about 8 miles from Marion, Ky., produced about five times as much fluorspar as in 1925, all of which was sold to the local mills.

The Kentucky Fluorspar Co., which has a mill a short distance south of the station of Marion, did a larger volume of business than in 1925; its sales consisted of about 59 per cent of ground fluorspar and 41 per cent of fluxing grades. This company does not operate any mines, but buys part or all of the output of many local mines and prospects. In 1926 it obtained its supply mainly from the Pogue, Lucile, Holly, Summers, Nancy Hanks, and Hodge mines. Considerable custom milling on a contract or tonnage basis is done at this mill.

During 1926 about 17,000 short tons of fluorspar was sold to the Kentucky and Franklin mills in Kentucky. By buying fluorspar outright or by treating it on contract or on a tonnage basis these mills thus enable many producers to work deposits that are too small to warrant the expense of installing the necessary equipment for preparing fluorspar that will meet the requirements of consumers. Moreover, they provide a market for producers who do not have direct market connections and for those who have mines with a capacity to produce in excess of the demand of their customers.

In Livingston County the largest producing mine is the Bonanza, situated about $1\frac{1}{2}$ miles southwest of Lola and about 18 miles west of Marion, the shipping point. This mine, which is equipped with a

mill of 50-ton capacity, was operated on a much reduced scale in 1926, producing about half as much fluorspar as in 1925.

The Nancy Hanks mine, about 11½ miles southeast of Salem and about 13 miles southwest of Marion, produced some fluorspar which was sold to the Kentucky mill at Marion.

The mining activities at the Hudson mine, about 2½ miles southwest of Salem, are directed mainly toward the production of zinc carbonate, although fluorspar occurs and some was produced in 1926.

The Butler and Cullens mines, near Salem, Livingston County, reported a small production of fluorspar in 1926.

The list that follows contains the names and office addresses of operators of fluorspar mines or mills in Kentucky that sold 300 tons or more each in 1926.

Operators of chief fluorspar mines or mills in Kentucky in 1926

Conger, Wring & Co.....	Mexico, Ky.
Eagle Fluor Spar Co.....	Wheeling, W. Va.
Franklin Fluorspar Co.....	Paducah, Ky.
Gugenheim Mining Co.....	Marion, Ky.
Haynes, W. V.....	Marion, Ky.
Henry & Frazer.....	Marion, Ky.
Holly Fluorspar Co.....	Marion, Ky.
Independent Fluorspar Co.....	Marion, Ky.
Kentucky Fluorspar Co.....	Marion, Ky.
Keystone Fluorspar & Lead Co.....	Hopkinsville, Ky.
Lafayette Fluorspar Co.....	Duluth, Minn.
Pigmy Corporation (Oglebay Norton & Co.).....	Cleveland, Ohio.
Stewart Spar Co.....	Marion, Ky.
United Mining Co.....	Lola, Ky.

NEW MEXICO

Shipments of fluorspar from New Mexico in 1926 aggregated 1,989 short tons, a decrease of 25 per cent from 1925.

The Tortugas mine, near Mesilla Park, Dona Ana County, was the main producer and shipper of fluorspar in New Mexico in 1926. The main shaft at this mine is sunk 286 feet. The fluorspar is reported to be blocked out from the 150-foot level to the 286-foot level, with the best showing on the lower level. In 1926 the operators of the Tortugas mine also worked a property near Deming, Luna County.

Sierra County reported considerable activity in the development of bodies of fluorspar and in installing equipment to treat the ore. At a property near Derry and 23 miles from Hatch, the shipping point, two claims have been reported leased to an operator who is said to be installing a mill that would produce 50 tons of finished product a day. The mill will consist of a decrepitator and tables.

Development work was reported carried on during 1926 at a property 4½ miles south of Hot Springs and about 25 miles from Engle, the shipping point. A mill that will handle 2 tons of crude ore an hour and make high-grade ground fluorspar has been completed. A small quantity of 100-mesh ground fluorspar averaging 96.5 per cent of calcium fluoride and 1.6 per cent of silica was shipped to a manufacturer of hydrofluoric acid. Equipment for concentrating the fluorspar to 98 per cent of calcium fluoride and 1 per cent of silica is said to be under construction.

The Lava Gap mine, in Socorro County, 28 miles from Oscuro, the shipping point, was nonproductive in 1926, but a small quantity of lump fluorspar from stock was shipped to a foundry.

Producers and shippers of fluorspar from New Mexico in 1926 were as follows:

Producers and shippers of fluorspar from New Mexico in 1926

Fluor Spar Mines of America-----	Hot Springs, N. Mex.
Hayner & Manasse-----	Las Cruces, N. Mex.

STOCKS OF FLUORSPAR AT MINES OR SHIPPING POINTS

According to the reports of producers the total quantity of fluor-spar in stock at the mines or at shipping points at the close of 1926 amounted to 68,997 short tons, an increase of 3 per cent over 1925. These stocks consisted of 20,731 tons of ready-to-ship fluorspar and of 48,266 tons of crude fluorspar still to be milled, calculated to be equivalent to about 27,000 tons of ready-to-ship fluorspar. As the quantity of fluorspar in stock piles must be partly estimated, the mine reports vary from year to year, preventing an absolute balance between the quantity mined and the quantity shipped and in stock.

Stocks of fluorspar at mines or shipping points in the United States, 1925-26, by States, in short tons

State	1925			1926		
	Crude ¹	Ready-to-ship	Total	Crude ¹	Ready-to-ship	Total
Arizona-----	175	225	400	175	225	400
Colorado-----	1,048	250	1,298	1,048	40	1,088
Illinois-----	12,266	12,530	24,796	4,516	13,193	17,709
Kentucky-----	30,318	9,216	39,534	41,419	6,933	48,352
Nevada-----	250	280	530	250	280	530
New Mexico-----	230	50	280	810	60	870
Texas-----	48	-----	48	48	-----	48
	44,335	22,551	66,886	48,266	20,731	68,997

¹ The greater part of this crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

IMPORTS AND EXPORTS ¹

The total imports of fluorspar into the United States in 1926 amounted to 75,671 short tons, valued ² at \$747,237, and are the largest ever recorded. The imports in 1926 showed an increase of 55 per cent in quantity and 59 per cent in total value over 1925. The value assigned to the foreign fluorspar averaged \$9.87 a ton. The cost to the consumers in the United States includes, in addition, the duty of \$5 a short ton, loading charges at the docks, the ocean freight

¹ Figures on imports were compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce; those on exports were supplied by the producers. No exports of fluorspar are recorded by the Bureau of Foreign and Domestic Commerce.

² "The value of imported merchandise * * * is the foreign value or the export value, whichever is higher, that is, the market value or the price at which the merchandise, at the time of exportation to the United States, is offered for sale in the principal markets of the country from which exported, including the cost of containers or coverings and all expenses (including any export tax) incident to placing the merchandise in condition ready for shipment to the United States, as defined in section 402 of the tariff act of 1922."

charges, and other charges, besides the freight charges from docks to manufacturers' plants.

The imports were equivalent to 59 per cent of the domestic shipments of fluorspar, as compared with 43 per cent in 1925.

The United Kingdom continues to be the chief source of imported fluorspar, supplying 39 per cent of the total in 1926. Most of the fluorspar from this source is of fluxing grade, and the cost to consumers in the United States is reported to have ranged between \$14.50 and \$19 a short ton, duty paid, at tidewater; the lower price was for material of off grade, some of which containing as low as 83 per cent of calcium fluoride and 6 per cent of silica was imported in 1926. According to reports of importers of 26,259 short tons of English fluorspar which was sold to steel manufacturers, the selling price of this quantity at tidewater, duty paid, averaged between \$16.75 and \$17 a short ton.

In 1926 the imports of fluorspar from Germany showed an increase of 75 per cent in quantity. Although the greater part of the fluorspar from Germany was sold for use in steel plants, some ground fluorspar was imported and sold to manufacturers of glass and enamel. A small quantity of fluorspar for use in the manufacture of hydrofluoric acid was also imported, the selling price of which was said to have ranged between \$28 and \$32 a short ton, duty paid, at tidewater. German fluorspar sold to manufacturers of glass and enamel was reported to have brought between \$30 and \$40 a short ton, duty paid, at tidewater, and that sold to steel plants between \$16 and \$17.50 a short ton, duty paid, at tidewater. About 1,400 short tons of ground fluorspar and more than 300 tons of acid-grade fluorspar were reported imported from Germany in 1926.

In 1926 the imports of fluorspar from Africa were a little more than in 1925. All of the fluorspar from this source is of acid grade and is used in the manufacture of hydrofluoric acid. Some of the fluorspar from Africa is said to have brought between \$28 and \$34 a short ton, duty paid, at tidewater.

In 1926 the imports of fluorspar from France—11,163 short tons—were nearly four and one-half times those of 1925 and reflect the increased operations of the newly opened mines in the Department of Var. Mineral Resources for 1925 (p. 22) contains some notes concerning these mines. They are 10 to 15 miles from the seacoast, and it was reported that a railroad to connect them with the coast was under construction in 1926. Except for a small quantity of fluorspar that was ground in the United States and sold for use in the glass industry and a few hundred tons that was sold to foundries, all of the fluorspar imported from France was sold for use in steel plants; the selling price ranged between \$15.75 and \$17.50 a short ton, duty paid, at tidewater. According to reports of importers of 10,418 short tons of French fluorspar which was sold to steel makers, the selling price of this quantity at tidewater, duty paid, averaged about \$16.50 a short ton in 1926.

In 1926 importations of fluorspar from Spain were recorded for the first time; although the quantity was only 2,948 tons it gives promise of increasing. The imports from this source probably reflect the activities of the Berta mine, near Barcelona, which was reopened in 1925 and seemingly contains a large deposit of fluorspar. Some notes concerning this mine are given on pages 45 to 48.

The imports of fluorspar from Italy decreased from 4,278 short tons in 1925 to 1,379 tons in 1926. Most of this fluorspar was sold for use in steel plants, and the selling price averaged about \$16.50 a short ton, duty paid, at tidewater. Ground fluorspar amounting to 440 short tons and containing 96 per cent or more of calcium fluoride and less than 2 per cent of silica was imported from Italy in 1926 and was sold to manufacturers of enameled and sanitary ware.

Although Canada is credited with exporting 1,109 short tons of fluorspar to the United States in 1926, the fluorspar apparently was not produced there but was probably imported into Canada from Europe and was reexported to the United States.

Chinese fluorspar was sold to steel manufacturers in California and Washington, and one shipment of 55 short tons was reported to have been sold to an eastern consumer for use in the manufacture of hydrofluoric acid.

The tariff act of 1922 increased the import duty on fluorspar from \$1.50 a long ton (\$1.34 a short ton) to \$5.60 a long ton (\$5 a short ton).

The distances that domestic fluorspar must be transported by rail from mines to steel plants in the Lehigh and Susquehanna Valleys of Pennsylvania are much greater than the distances that foreign fluorspar must be moved from the ports of entry to these plants; moreover, a large part of the imported material is carried as ballast, making possible a lower market price than would have to be charged if it were carried as a primary cargo. Except when ocean freight rates are moderate, however, foreign fluorspar can not compete readily in American markets, because it is not generally of such high grade as the mechanically cleaned domestic product. As the value of fluorspar depends mainly upon its purity, comparison of the American fluorspar with foreign fluorspar should be made not merely on the basis of price per ton but on the basis of quality as well.

Fluorspar imported into the United States, 1925-26, by countries

[General imports]

Country	1925			1926		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Africa:						
British South	7,906	\$108,647	\$13.74	7,534	\$123,734	\$16.42
British West				610	7,933	13.00
Portuguese East				362	4,835	13.36
Belgium	78	1,624	20.82	31	566	18.26
Canada				1,109	10,310	9.30
China	559	5,816	10.40	645	5,992	9.29
Czechoslovakia	27	591	21.89			
France	2,537	20,887	8.23	11,163	90,737	8.13
Germany	11,680	103,845	8.89	20,465	171,769	8.39
Italy	4,278	32,208	7.53	1,379	15,434	11.19
Soviet Russia in Asia				18	277	15.39
Spain				2,948	33,915	11.50
United Kingdom	21,635	195,229	9.02	29,407	281,735	9.58
	48,700	468,847	9.63	75,671	747,237	9.87

Producers of fluorspar reported exports in 1926 amounting to 2,132 short tons, valued at \$34,915, or \$16.38 a ton, as compared with 1,055 tons, valued at \$17,574, or \$16.66 a ton, in 1925. All of the exported fluorspar went to Canada in 1926.

Fluorspar reported by producers as exported from the United States, 1920-1926

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1920-----	2,764	\$65,475	\$23.69	1924-----	617	\$14,489	\$23.48
1921-----				1925-----	1,055	17,574	16.66
1922-----	2,296	40,966	17.84	1926-----	2,132	34,915	16.38
1923-----	1,144	25,312	22.13				

USES OF FLUORSPAR

Fluorspar has many uses, but its most important use is in metallurgical industries, in which was used about 86 per cent of the total fluorspar consumed in the United States in 1926. Other large users are the ceramic industries, which used about 8 per cent of the total quantity consumed in 1926, and the chemical industries, which used more than 6 per cent of the total. A little fluorspar is used in optical instruments.

METALLURGICAL INDUSTRIES

Steel.—The bulk of the fluorspar mined in the United States and most of that imported is used in the steel industry, principally by manufacturers using the basic open-hearth process, in which it is added as a flux to the furnace charge. Fluorspar gives fluidity to the slag and facilitates the passage of objectionable impurities, such as sulphur and phosphorus, into the slag.

Although fluorspar is used at virtually all basic open-hearth steel plants, it is not used in all furnace heats. The addition of ore (hematite) to the furnace heats to eliminate carbon is said to make the use of fluorspar unnecessary, as in such heats the oxide of iron in the slag reacts to form a sufficiently fluid slag. When high-manganese pig iron is used, less fluorspar is needed than for ordinary pig iron. According to Smith,³ the consumption of fluorspar was 12 per cent less in heats made with 1.5 to 2 per cent of manganese iron than in those made with 1 per cent and less.

The average quantity of fluorspar used by individual plants per ton of basic open-hearth steel made varies widely, usually ranging between 1 and 35 pounds. In general, the average is between 7 and 8 pounds, which is a very small proportion of the furnace charge. The following table shows the variation in average consumption of fluorspar per ton of basic open-hearth steel of certain manufacturers who make about 70 per cent of the total.

³ Smith, A. W., "High-manganese iron possesses advantages": Daily Metal Trade, sec. 4, Oct. 23, 1926, p. 2.

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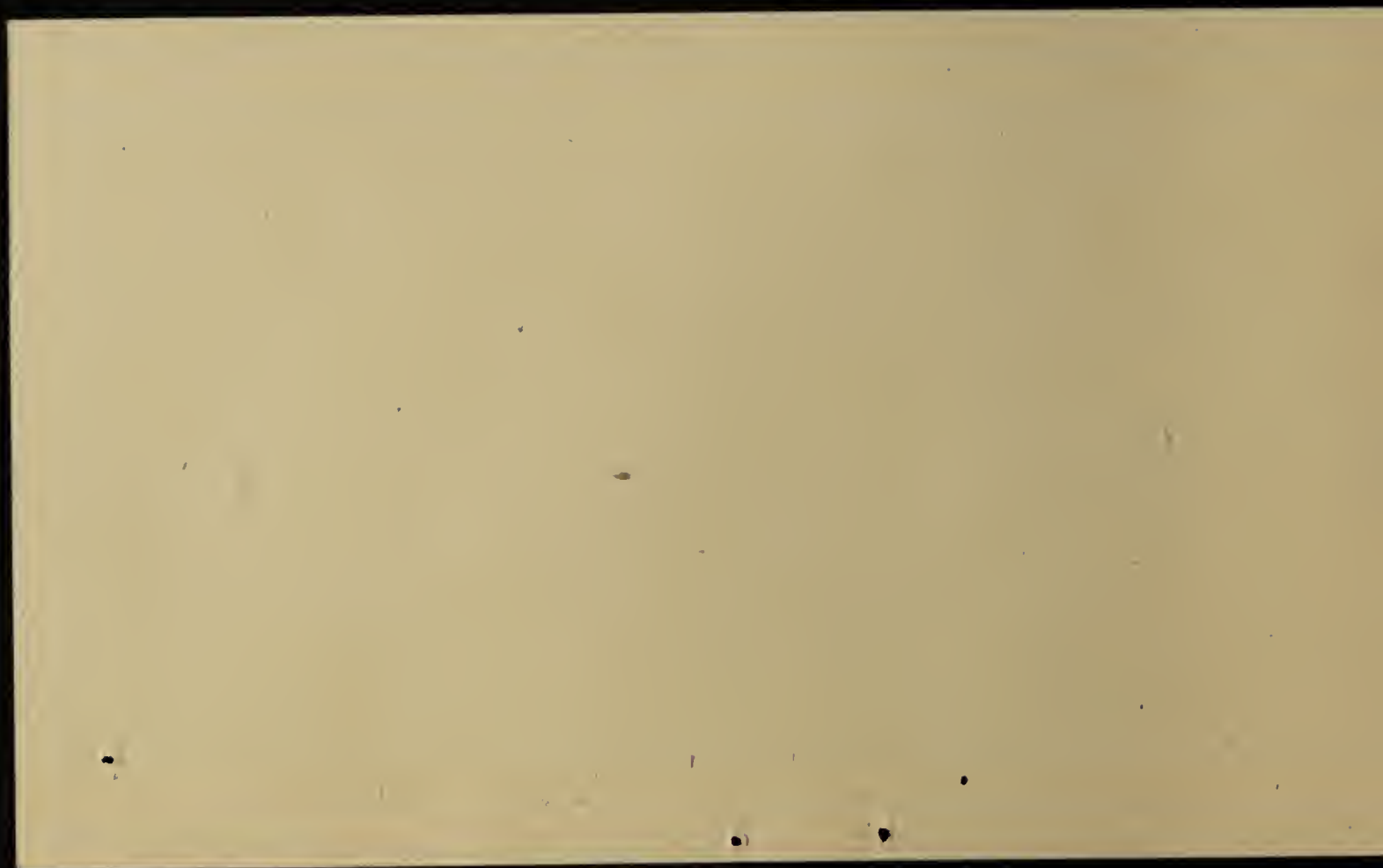
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Average consumption of fluorspar per ton of steel, 1921-1926, in pounds

1921	1922	1923	1924	1925	1926
18.644	18.476	16.176	19.295	13.983	12.959
4.843	7.113	8.973	7.409	7.893	8.219
7.633	6.552	6.416	6.857	6.224	5.700
9.578	8.804	7.780	5.365	4.809	6.270
7.086	5.308	5.799	5.383	4.568	4.313
9.224	7.051	6.475	7.652	9.090	11.225
11.578	9.331	9.880	8.747	8.656	8.541

Manufacturers of basic open-hearth steel generally require that fluorspar be in pieces that will pass through a 1-inch screen, the fines to be not more than 15 per cent of the total. However, variation in size requirements is not uncommon, and fluorspar in lumps several inches in diameter is sometimes used. Almost universally such manufacturers specify that fluorspar show by analysis not less than 85 per cent of calcium fluoride, not more than 5 per cent of silica, and not more than 0.3 per cent of sulphur.

Thus, as generally computed; one part of silica requires 2½ parts of fluorspar to flux it; a fluorspar containing 85 per cent of calcium fluoride and 5 per cent of silica would be equivalent to 72½ units of net calcium fluoride. With some manufacturers a sliding scale is acceptable, and for each 2½ units of calcium fluoride above 85 per cent the silica is allowed to go up 1 per cent. In other words, a fluorspar containing 87½ per cent of calcium fluoride and 6 per cent of silica is equivalent to one containing 85 per cent of calcium fluoride and 5 per cent of silica. As a rule, there are no guarantees on the other elements, but the consumer prefers the absolute minimum of the lead and zinc. However, fluorspar carrying as little as 80 per cent of calcium fluoride and 6 to 7 per cent of silica is occasionally used. Furthermore, some consumers do not object to a larger amount of sulphur.

Fluorspar is used to some extent in the manufacture of steel by the electric-furnace process, mainly in making alloy steels. The action of fluorspar in this process is similar to that on the slag in the basic open-hearth process, and generally fluorspar of the same grade is used. The quantity used per ton of steel made, however, is much larger, ranging from a few pounds to as much as 80 and averaging about 23 pounds.

Analyses of gravel fluorspar used in steel plants

CaF ₂	SiO ₂	CaCO ₃	Fe ₂ O ₃	Al ₂ O ₃	S	BaSO ₄
<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
87.50	4.00	7.20	0.60	0.55	0.12	-----
86.7	4.8	7.5	-----	-----	-----	4.16
88.92	3.07	1.23	-----	1.96	-----	-----
87.8	3.10	-----	3.06	-----	-----	-----

Ferro-alloys.—To a small extent fluorspar is used as a flux in making ferro-alloys by the electric-furnace process. For this purpose a

fluorspar comparatively high in calcium fluoride and low in silica and fine enough to give good distribution is required.

Foundry.—Fluorspar is used for the same purpose in foundry practices as in the basic open-hearth steel process, and the requirements as to analyses are virtually the same. The cupolas are so constructed, however, that the fluorspar need not be in small sizes, as many users believe better results are obtained if fluorspar in lump form is used. Although there are several thousand foundries scattered throughout the United States, the total quantity of fluorspar consumed annually is small. Some foundries use it as standard practice and some use it only occasionally, but by far the greater number do not use fluorspar at any time.

The results of a series of investigations on the use of fluorspar in cupola practice have been recorded in *Stahl und Eisen*, an abstract of which recently appeared in the *Iron Age*.⁴

Analyses of fluorspar used in cupolas

CaF ₂	SiO ₂	CaCO ₃
<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
87.0	4.5	7.5
88.5	4.3	6.0
92.0	3.5	3.67
82.0	8.0	1.3

Other metallurgical uses.—Small quantities of fluorspar are used in other metallurgical operations, the quality and size of fluorspar required depending on the particular use. For instance, in the production of nickel and monel metal a lump fluorspar high in calcium fluoride and absolutely free from lead is required. In reducing aluminum a ground fluorspar showing by analysis 98.5 per cent of calcium fluoride, 0.62 per cent of silica, and 0.74 per cent of calcium carbonate is generally used.

CERAMIC INDUSTRIES

Glass.—The chief consumers of fluorspar in the glass industry are manufacturers of opal or opaque glass and colored glasses, which are used for many purposes, such as for lamp globes, shades, and bulbs, soda fountains, liners for fruit jars, containers for toilet and medicinal preparations, bars and rods for lavatories, tableware, and novelties.

Fluorspar used in the glass industry is either packed in bags or barrels or shipped in bulk. It is generally ground so that approximately 55 per cent will pass a 100-mesh screen and approximately 15 per cent through a 200-mesh screen. Fluorspar used in the glass industry generally contains 95 per cent or more of calcium fluoride, not more than 3 per cent of silica, 1 per cent or less of calcium carbonate, and not more than 0.12 per cent of iron oxide.

The specifications of a large consumer of fluorspar in the glass industry follow, and with some variations are probably representative:

Our specifications call for a limit of 0.12 per cent iron oxide content. Really we would object strongly if we obtained much fluorspar with that much iron

⁴ *Iron Age*, "Fluorspar in cupola practice"; Apr. 7, 1927, pp. 997-998.

in it, as it colors the glass, and we have been receiving fluorspar from responsible sources around 0.06 per cent.

Calcium fluoride content has been placed at a minimum of 90 per cent. However, we receive most of it well above 95 per cent, and our price is based on that. If the diluting material is something such as silica which is used in the glass, it would not interfere with the process, but would with the price.

Calcium carbonate content must not vary too much, as it affects the formula used in the glass batch. We do not want lead, zinc, or sulphur, so this specification is not a usual one in the glass trade. We do this because we neutralize these materials rather accurately, and too much of them will give us an off shade in color.

All our material is bought in bulk and is finely ground, generally nearly 100 mesh. We can stand considerable variation in this.

Enamels.—Fluorspar is used as an ingredient in enamels for coating hospital and kitchen ware, plumbing fixtures, barber and beauty-parlor chairs, linings for refrigerators, table and counter tops, reflectors, signs, stove parts, facing for brick and tile, art pottery, structural materials, earthen cooking ware, and other similar products.

As in the glass industry, enamelers require a high-grade fluorspar, usually a product containing at least 95 per cent of calcium fluoride. A small amount of silica is not injurious, but as calcium carbonate tends to increase the brittleness of the enamel it must be kept as low as possible. Iron, lead, zinc, and sulphur are objectionable impurities, as these elements in any appreciable quantity would stain or color the enamel. The fluorspar is generally ground so that approximately 80 per cent will pass through a 100-mesh screen and 15 per cent through a 200-mesh screen.

Analyses of fluorspar used in the manufacture of glass and enamel

CaF ₂	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	CaCO ₃	MgCO ₃	S
<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
97.86	0.72	0.06	0.08	1.01	0.26	Trace.
97.403	1.55	.14	.26	.54	-----	0.027
97.54	.98	.50		.98	-----	
97.38	1.13	.28		1.21	-----	
98.53	.76	.34		.37	-----	
96.92	1.24	.88	-----	1.28	-----	
95.00	2.50	.12	-----		-----	
97.15	1.60	.08	-----	.90	-----	

Cement.—Small quantities of fluorspar have been used in the recovery of potassium compounds from flue dust of cement works in the United States, but this saving of potash has now been discontinued. Fluorspar is used more or less in the manufacture of Portland cement abroad, but little is now used in this industry in the United States. In 1926 one shipment of fluorspar was reported made to a cement plant. According to an article in a recent publication,⁵ the addition of fluorspar to the raw materials permits the lowering of the fusing point about 400°; thereby resulting in considerable economy in fuel. It is stated that the addition of only 0.25 to 1 per cent of fluorspar was the practice for some time, but recent experiments have shown that the addition of 3 to 5 per cent of fluorspar gives the best result. The clinker obtained in this way is very fragile, and grinding is therefore greatly facilitated, with an appreciable economy in power.

⁵ Chermette, A., and Sire, L., "Le spath fluor dans le massif central. Ses applications" [Fluorspar in the central massif and its uses]: Rev. ind. min., No. 143, Dec. 1, 1926, Mem., pp. 515-528, Paris, 1926.

The addition of fluorspar is said to eliminate the formation of rings in the rotary kilns, which reduces to a minimum the periods of stoppage and increases the life of the refractory lining.

CHEMICAL INDUSTRIES

Hydrofluoric acid.—Fluorspar is the basic material used in the manufacture of hydrofluoric acid, which finds considerable use in the electrolytic refining of metals, the etching of glassware, and in the manufacture of fluorides used in various chemical processes, and for insecticides. The manufacture of hydrofluoric acid consists, essentially, of treating high-grade ground fluorspar with sulphuric acid.

The manufacture of hydrofluoric acid requires a finely ground fluorspar, generally ranging between 80 and 100 mesh. Most manufacturers of hydrofluoric acid, however, prefer the fluorspar either in the lump or gravel form and to grind the material in their own plants.

Moreover, the manufacture of hydrofluoric acid requires a high-grade fluorspar, manufacturers generally specifying a minimum of 98 per cent of calcium fluoride and a maximum of 1 per cent of silica. However, it is reported that a product containing as low as 97 per cent of calcium fluoride and as high as 1.5 per cent of silica can be used for this purpose, but such a fluorspar would not demand more than 85 per cent of the price of the higher-grade product. Less than 1 per cent of calcium carbonate is generally specified, as the presence of 1 per cent or more causes considerable foaming upon mixing.

An analysis of a shipment of "acid-grade" fluorspar from the Illinois-Kentucky field follows:

	Per cent		Per cent
CaF ₂	99. 07	Fe ₂ O ₃ -Al ₂ O ₃	0. 292
SiO ₂ 24	CO ₂ 15
CaO 23	S 018

Cyanamid and calcium carbide.—Fluorspar is used to facilitate the fusion and contact of products in the manufacture of calcium carbide and cyanamid; the carbide then flows more readily.⁶

OPTICAL FLUORSPAR

A comparatively small quantity of fluorspar is used for optical purposes. According to the Bureau of Standards,⁷ fluorspar is useful in correcting the color and spherical aberration errors in lenses, especially for microscopes and small telescopes. Fluorspars suitable for optical instruments must be as clear as glass; that is, it must be free from cloudiness, inclusions, and cracks (incipient cleavage marks). Colorless material is most desired, but samples which are faintly tinged with yellow or green may be valuable.

CONSUMPTION—STOCKS AT CONSUMERS' PLANTS

The figures on consumption of fluorspar in 1926 and stocks at consumers' plants on December 31, 1926, given in the following table, are believed to fall not far short of the total for the United States.

⁶ Chermette, A., and Sire, L., Op. cit.

⁷ Circular letter, dated May 8, 1918.

Thus, the figures for basic open-hearth steel represent all plants, including an estimate for two companies not reporting, and are based on reports of manufacturers who produced 99 per cent of the total. Similarly, all electric-steel and ferro-alloy manufacturers that use fluorspar are represented. The smaller foundries, some of which use a little fluorspar, were not canvassed, so that the figures for this industry are incomplete, as also are the figures for hydrofluoric acid, one manufacturer not reporting. The figures for the ceramic industry are believed to be practically complete.

Fluorspar reported consumed and in stock in the United States in 1926, by industries

Industry	Compa- nies rep- resented	Fluorspar consumed (short tons)	Stocks at consumers' plants Dec. 31 (short tons)
Basic open-hearth steel.....	75	142, 000	70, 000
Electric-furnace steel.....	61	4, 800	2, 000
Foundry.....	68	4, 335	1, 400
Ferro-alloys.....	5	462	180
Hydrofluoric acid.....	5	7, 591	12, 153
Enamel and sanitary ware.....	71	6, 677	935
Glass.....	44	7, 973	1, 342
Miscellaneous.....	14	719	252
	-----	174, 557	88, 262

The table that follows shows the relation of the consumption of fluorspar to the production of basic open-hearth steel for the 5-year period 1922 to 1926 and the stocks of fluorspar at such steel plants at the close of each of these years. The stocks at the close of 1926 are the largest recorded since such statistics have been collected by the Bureau of Mines.

Consumption and stocks of fluorspar at basic open-hearth steel plants, 1922-1926

	1922	1923	1924	1925	1926
Production of basic open-hearth steel.....long tons..	28, 387, 171	34, 665, 021	30, 719, 523	37, 087, 342	39, 653, 315
Consumption of fluorspar in basic open-hearth steel production.....short tons..	105, 000	140, 000	119, 800	137, 700	142, 000
Consumption of fluorspar per ton of steel made.....pounds.....	7. 4	8. 1	7. 8	7. 4	7. 2
Stocks of fluorspar on hand at steel plants at end of year.....short tons..	65, 000	49, 900	64, 000	49, 400	70, 000

MARKETING

Prices of domestic fluorspar are quoted on the basis of the short ton (2,000 pounds) f. o. b. cars at the nearest shipping point to mills or mines. Gravel and lump fluorspar are generally shipped in bulk in open-top cars. Ground fluorspar is shipped both in bulk in box cars lined with heavy paper and packed in bags with a capacity of 125 pounds each or barrels with a capacity of from 450 to 500 pounds each. When packed in bags and barrels, a charge, depending

on the cost of the containers, is added. If the bags are in good condition, and the freight prepaid to the mine, they may be returned for repacking, in which case the usual allowance of 10 cents a bag is made. The barrels are not returnable.

Most of the large consumers buy the bulk of their fluorspar on contract, generally covering a definite tonnage to be delivered within a stated time and specifying the minimum content of calcium fluoride and the maximum contents of impurities that will be accepted. The contract may or may not include penalties for excesses of impurities above the specified limits. Premiums, however, are seldom paid for unusual purity.

Most of the domestic fluorspar of commerce is sold through established sales agencies, who handle other raw materials used in the iron, steel, ceramic, and chemical industries and are thus in close contact with the consumers. Such sales agencies either operate their own mines or have contracts with producers whereby the producer agrees to supply and the sales agency agrees to handle the entire output of the producer. Thus a producer who does not have selling connections and who is unable to guarantee a definite tonnage or to make delivery over a definite period finds it difficult to sell direct to consumers. In the Illinois-Kentucky district, however, the local mills provide a market for such producers.

MARKETS

The bulk of the fluorspar sold in the United States is used by basic open-hearth steel plants, which are scattered over 24 States and provide the chief markets for fluorspar. Most of these plants, however, are in the eastern part of the United States and are more or less centralized in certain well-known districts.

The largest single market for fluorspar in the East, as well as in the United States, is at basic open-hearth steel plants in the Pittsburgh district, Pennsylvania, which in 1926 consumed about 30,000 short tons of fluorspar, or about 21 per cent of the total consumed in the basic open-hearth steel industry.

The next largest markets in the East are in the Youngstown-Canton-Sharon and eastern Pennsylvania districts, which consumed about 17,000 tons each in 1926.

Other important markets are at Buffalo, N. Y.; Johnstown, Pa.; Cleveland and Steubenville, Ohio; Weirton, W. Va.; and at or near the Atlantic coast in Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, and Maryland. The total consumption of fluorspar in these districts amounted to about 30,000 tons in 1926.

Thus, the basic open-hearth steel plants at and east of Cleveland, Massillon, and Steubenville, Ohio, consumed about 94,000 tons of fluorspar in 1926, or about 66 per cent of the total consumed by basic open-hearth steel plants in the United States.

Costs of production and transportation limit the markets in which sellers of fluorspar can profitably compete; the import duty further limits the markets for imported fluorspar. The cost of producing fluorspar abroad, chiefly in England, Germany, and France, is relatively so much lower than the cost of production in the Illinois-Kentucky district that, notwithstanding a duty of \$5 a short ton,

fluorspar imported from these sources is sold in western Pennsylvania and to a small extent in eastern Ohio in stiff competition with that from the Illinois-Kentucky district. The market in this area is therefore more or less divided between domestic and imported fluorspar.

As the cost of delivering fluorspar from abroad to the plants near the Atlantic coast in Pennsylvania, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, and Maryland, as well as at Buffalo, N. Y., is much less than the cost of delivering from the Illinois-Kentucky district, comparatively little domestic fluorspar is sold to basic open-hearth steel plants in this area.

In the mid-west the principal markets for fluorspar are at basic open-hearth steel plants at Chicago, Peoria, and Granite City, Ill.; Gary and Indiana Harbor, Ind.; St. Louis and Kansas City, Mo.; and Duluth, Minn. The total consumption in this area amounted to about 29,000 short tons in 1926. The largest market in this area and the second largest in the United States is the Chicago-Indiana Harbor-Gary district; the basic open-hearth steel plants in this district consumed about 25,000 short tons of fluorspar in 1926, or about 18 per cent of the total consumed in the basic open-hearth steel industry. The greater part of the fluorspar sold to steel plants in the mid-west comes from the Illinois-Kentucky district, although most of that produced in the Colorado-New Mexico district in 1926 was shipped to Chicago, Gary, Duluth, and Kansas City.

In the South important markets for fluorspar are in the Birmingham district, Alabama City, Ala., and Atlanta, Ga. Practically all of the fluorspar sold in this market is from the Illinois-Kentucky district.

In the West the largest consumer of fluorspar is the steelworks at Pueblo, Colo.; a mine owned by the operators of the steelworks supplies this plant with fluorspar, so that a market does not exist.

On the Pacific coast the largest consumers of fluorspar are the basic open-hearth steel plants near Los Angeles, San Francisco, Pittsburg, and Torrance, Calif., and Youngstown, Wash., but the quantity consumed annually is comparatively small and is supplied by the Colorado-New Mexico district and by imported fluorspar, chiefly from China and England.

In 1926 the total consumption of fluorspar at steel plants in the West was about 5,600 short tons.

The largest markets for fluorspar used in the glass industry are in Pennsylvania, Indiana, and West Virginia, the plants in these States using about 93 per cent of the total consumed in this industry in 1926. The largest markets in this area are at Washington, Pa.; Muncie, Ind.; and Fairmont, W. Va.

The markets for fluorspar used in making enamels, including vitrolite, are more widely distributed than in the glass industry; in 1926 about 80 per cent of the total was consumed in West Virginia, Pennsylvania, Wisconsin, Indiana, Illinois, and Ohio. The largest markets for fluorspar in this industry are at Parkersburg, W. Va.; Pittsburgh and New Brighton, Pa.; Kohler, Wis.; Noblesville and Indianapolis, Ind.; Chicago, Ill.; and Cuyahoga Heights, Cleveland, and Mansfield, Ohio.

Foundries offer small and widely scattered markets for fluorspar. Those using fluorspar are located chiefly in Illinois, New York, Michigan, Wisconsin, and Indiana.

The largest consumers of fluorspar in the chemical industry are at St. Louis, Mo.; Cleveland, Ohio; Newell, Pa.; Brooklyn, N. Y.; and Clayton, Del.

CONSUMERS OF FLUORSPAR

As the need of a directory of consumers of fluorspar in the United States has been felt for some time, an attempt has been made to list them. As will be seen from the following list, the consumers have been classified according to the industries in which fluorspar is used, and each industry has been arranged alphabetically by States and by location of the consuming plant. Where information was obtainable the address of the purchasing agent is given. Although the directory is not as complete as is desirable, it is believed that all of the larger consumers are included. Any additions or corrections that the reader may send to the Bureau of Mines will be appreciated.

Consumers of fluorspar in basic open-hearth steel plants in the United States

Name of consumer	Address of purchasing agent	Location of plant
Alabama:		
Gulf States Steel Co.....	Birmingham.....	Alabama City.
Tennessee Coal, Iron & Railroad Co.....	do.....	Ensley, Fairfield.
California:		
Southern California Iron & Steel Co.....	Huntington Park.....	Huntington Park.
Judson Manufacturing Co.....	San Francisco.....	Oakland.
Columbia Steel Corporation.....	do.....	Pittsburg, Torrance.
Pacific Coast Steel Co.....	do.....	South San Francisco.
Colorado: Colorado Fuel & Iron Co.....	Denver.....	Pueblo.
Connecticut: American Tube & Stamping Co.....	Bridgeport.....	Bridgeport.
Delaware:		
Worth Steel Co.....	Claymont.....	Claymont.
Penn Seaboard Steel Corporation.....	New Castle.....	New Castle.
Georgia: Atlantic Steel Co.....	Atlanta.....	Atlanta.
Illinois:		
Laclede Steel Co.....	St. Louis, Mo.....	Alton.
Railway Steel-Spring Co.....	New York, N. Y.....	Chicago Heights.
American Steel Foundries.....	Chicago.....	East St. Louis, Granite City..
Commonwealth Steel Co.....	St. Louis, Mo.....	Granite City.
National Enameling & Stamping Co.....	Granite City.....	Do.
National Malleable & Steel Castings Co.....	Cleveland, Ohio.....	Melrose Park.
Keystone Steel & Wire Co.....	Peoria.....	Peoria.
Illinois Steel Co.....	Chicago.....	South Chicago.
International Harvester Co.....	do.....	Do.
Interstate Iron & Steel Co.....	do.....	Do.
Indiana:		
Illinois Steel Co.....	Chicago, Ill.....	Gary.
Inland Steel Co.....	Indiana Harbor.....	Indiana Harbor.
Youngstown Sheet & Tube Co.....	Youngstown, Ohio.....	Do.
Kokomo Steel & Wire Co.....	Kokomo.....	Kokomo.
Iowa:		
Bettendorf Co.....	Bettendorf.....	Bettendorf.
Zimmerman Steel Co.....	do.....	Do.
Kentucky:		
American Rolling Mill Co.....	Middletown, Ohio.....	Ashland.
Andrews Steel Co.....	Newport.....	Newport.
Maryland: Bethlehem Steel Co.....	Bethlehem, Pa.....	Sparrows Point.
Massachusetts: American Steel & Wire Co.....	Cleveland, Ohio.....	Worcester.
Michigan: Ford Motor Co.....	Detroit.....	Springwells.
Minnesota: Minnesota Steel Co.....	Chicago, Ill.....	Duluth.
Missouri:		
Sheffield Steel Corp.....	Kansas City.....	Kansas City.
Scullin Steel Co.....	St. Louis.....	St. Louis.
New Jersey:		
Crucible Steel Co. of America.....	New York, N. Y.....	Harrison.
John A. Roebling's Sons Co.....	Trenton.....	Roebling.

Consumers of fluorspar in basic open-hearth steel plants in the United States—
Continued

Name of consumer	Address of purchasing agent	Location of plant
New York:		
Donner Steel Co.....	Buffalo.....	Buffalo.
Wickwire Spencer Steel Co.....	New York.....	Do.
Wickwire Bros.....	Cortland.....	Cortland.
Gould Coupler Co.....	Depew.....	Depew.
Bethlehem Steel Co.....	Bethlehem, Pa.....	Lackawanna.
Ohio:		
American Steel Foundries.....	Chicago, Ill.....	Alliance.
Central Alloy Steel Corporation.....	Massillon.....	Canton, Columbia Heights.
American Steel & Wire Co.....	Cleveland.....	Cleveland.
Bourne-Fuller Co.....	do.....	Do.
Corrigan, McKinney Steel Co.....	do.....	Do.
Otis Steel Co.....	do.....	Do.
Ohio Steel Foundry Co.....	Lima.....	Lima.
National Tube Co.....	Pittsburgh, Pa.....	Lorain.
Sharon Steel Hoop Co.....	Sharon, Pa.....	Lowellville.
Mansfield Sheet & Tin Plate Co.....	Mansfield.....	Mansfield.
Marion Steam Shovel Co.....	Marion.....	Marion.
American Rolling Mill Co.....	Middletown.....	Middletown.
Crucible Steel Co. of America.....	New York, N. Y.....	Norwalk.
Jackson Valve & Manufacturing Co.....	Portsmouth.....	Portsmouth.
Wheeling Steel Corporation.....	Wheeling, W. Va.....	Portsmouth, Steubenville.
Bonney-Floyd Co.....	Columbus.....	South Columbus.
Buckeye Steel Castings Co.....	do.....	Do.
Follansbee Bros. Co.....	Pittsburgh, Pa.....	Toronto.
Trumbull Steel Co.....	Warren.....	Warren.
Carnegie Steel Co.....	Pittsburgh, Pa.....	Youngstown.
Republic Iron & Steel Co.....	Youngstown.....	Do.
Youngstown Sheet & Tube Co.....	do.....	Do.
Pennsylvania:		
Bethlehem Steel Co.....	Bethlehem.....	Bethlehem, Coatesville, Johnstown, Steelton.
Allegheny Steel Co.....	Brackenridge.....	Brackenridge.
West Penn Steel Co.....	do.....	Do.
Standard Steel Works Co.....	Philadelphia.....	Burnham.
Forged Steel Wheel Co.....	Pittsburgh.....	Butler.
Carnegie Steel Co.....	do.....	Clairton, Duquesne, Farrell, Munhall, North Braddock.
Lukens Steel Co.....	Coatesville.....	Coatesville.
Colonial Steel Co.....	Pittsburgh.....	Colona (Monaca).
American Steel & Wire Co.....	Cleveland, Ohio.....	Donora.
Erie Forge Co.....	Erie.....	Erie.
Erie Forge & Steel Co.....	do.....	Do.
Pittsburgh Steel Foundry Co.....	Pittsburgh.....	Glassport.
Central Iron & Steel Co.....	Harrisburg.....	Harrisburg.
Harrisburg Pipe & Pipe Bending Co.....	do.....	Do.
Alan Wood Iron & Steel Co.....	Philadelphia.....	Ivy Rock.
Firth-Sterling Steel Co.....	McKeesport.....	McKeesport.
Pittsburgh Crucible Steel Co.....	New York, N. Y.....	Midland.
Pittsburgh Steel Co.....	Pittsburgh.....	Monessen.
Midvale Co.....	Philadelphia.....	Nicetown.
Edgewater Steel Co.....	Oakmont.....	Oakmont.
American Bridge Co.....	Pittsburgh.....	Pencoyd.
Phoenix Iron Co.....	Philadelphia.....	Phoenixville.
Crucible Steel Co. of America.....	New York, N. Y.....	Pittsburgh.
Jones & Laughlin Steel Co.....	Pittsburgh.....	Pittsburgh, Woodlawn.
Eastern Steel Co.....	Pottsville.....	Pottsville.
American Steel Foundries.....	Chicago, Ill.....	Sharon.
National Malleable & Steel Castings Co.....	Cleveland, Ohio.....	Do.
American Sheet & Tin Plate Co.....	Pittsburgh.....	Vandergrift.
Verona Steel Castings Co.....	do.....	Verona.
Rhode Island: Washburn Wire Co.....	Phillipsdale.....	Phillipsdale.
Utah: Utah Steel Corporation.....	Midvale.....	Midvale.
Washington: Pacific Coast Steel Co.....	Seattle.....	Youngstown.
West Virginia:		
Follansbee Bros. Co.....	Pittsburgh, Pa.....	Follansbee.
Weirton Steel Co.....	Weirton.....	Weirton.
Wisconsin: Bucyrus Co.....	South Milwaukee.....	South Milwaukee.

Consumers of fluorspar in electric-furnace steel plants in the United States

Name of consumer	Address of purchasing agent	Location of plant
Alabama: Anniston Electric Steel Corporation	Anniston	Anniston.
California:		
Best Steel Casting Co.	Oakland	Elmhurst.
Alloy Steel & Metals Co.	Los Angeles	Los Angeles.
American Manganese Steel Co.	Chicago, Ill.	Los Angeles, Oakland.
Southern Pacific Railroad Co.	San Francisco	Sacramento.
Columbia Steel Corporation	do	Torrance.
Union Tool Co.	Torrance	Do.
Colorado: American Manganese Steel Co.	Chicago, Ill.	Denver.
Connecticut: Yale & Towne Manufacturing Co.	Stamford	Stamford.
Delaware: American Manganese Steel Co.	Chicago, Ill.	New Castle.
District of Columbia: Naval gun factory	Washington	Washington.
Georgia: Glover Machine Works	Marietta	Marietta.
Illinois:		
Burnside Steel Co.	Chicago	Chicago.
Crane Co.	do	Do.
Pettibone Mulliken Co.	do	Do.
Trojan Electric Steel Co.	do	Do.
American Manganese Steel Co.	do	Chicago Heights.
National Malleable & Steel Castings Co.	Cleveland, Ohio	Cicero.
Illinois Steel Co.	Chicago	South Chicago.
McCord & Co.	West Pullman	West Pullman.
Indiana: Damascus Steel Casting Co.	New Brighton, Pa.	Hammond.
Kansas: Locomotive Finished Material Co.	Atchison	Atchison.
Massachusetts:		
General Electric Co.	Schenectady, N. Y.	Lynn, Pittsfield.
Electric Steel Castings Co.	Turner Falls	Turner Falls.
Watertown Arsenal	Watertown	Watertown.
Michigan:		
Clark Equipment Co.	Buchanan	Buchanan.
Calumet & Hecla Consolidated Copper Co.	Calumet	Calumet.
Missouri: Southern Manganese Steel Co.	Chicago, Ill.	St. Louis.
Nebraska: Omaha Steel Works	Omaha	Omaha.
New Jersey: Driver-Harris Co.	Harrison	Harrison.
New York:		
Onondaga Steel Co.	Syracuse	Dewitt.
Atlas Alloy Steel Corporation	Dunkirk	Dunkirk.
Simonds Saw & Steel Co.	Lockport	Lockport.
General Electric Co.	Schenectady	Schenectady.
Ludlum Steel Co.	Watervliet	Watervliet.
Ohio:		
Hadfield-Penfield Steel Co.	Bucyrus	Bucyrus.
Central Alloy Steel Corporation	Massillon	Canton.
Timken Roller Bearing Co.	Canton	Do.
National Malleable & Steel Castings Co.	Cleveland	Cleveland.
Marion Steam Shovel Co.	Marion	Marion.
American Rolling Mill Co.	Middletown	Middletown.
Allis-Chalmers Manufacturing Co.	Milwaukee, Wis.	Norwood.
Pennsylvania:		
Vulcan Crucible Steel Co.	Aliquippa	Aliquippa.
Bethlehem Steel Co.	Bethlehem	Bethlehem, Steelton.
Allegheny Steel Co.	Brackenridge	Brackenridge.
Braeburn Alloy Steel Corporation	Braeburn	Braeburn.
Universal Steel Co.	Bridgeville	Bridgeville.
Union Electric Steel Corporation	Pittsburgh	Carnegie.
Colonial Steel Co.	do	Colona (Monaca).
Walworth Co.	Boston, Mass.	Greenburg.
Latrobe Electric Steel Co.	Latrobe	Latrobe.
Vanadium Alloys Steel Co.	do	Do.
Firth-Sterling Steel Co.	McKeesport	McKeesport.
Milton Manufacturing Co.	Milton	Milton.
Le Moyne Steel Co.	Pittsburgh	Monongahela.
Damascus Steel Casting Co.	New Brighton	New Brighton.
Midvale Co.	Philadelphia	Nicetown.
Henry Disston & Sons Iron & Steel Works	do	Philadelphia.
Philadelphia Navy Yard	do	Do.
Carpenter Steel Co.	Reading	Reading.
Reading Steel Casting Co.	do	Do.
National Malleable & Steel Castings Co.	Cleveland, Ohio	Sharon.
Jessop Steel Co.	Washington	Washington.
Texas: Hughes Tool Co.	Houston	Houston.
Virginia:		
Old Dominion Iron & Steel Works	Richmond	Belle Isle (Richmond).
Newport News Shipbuilding & Dry Dock Co.	Norfolk	Norfolk.
Norfolk Navy Yard	do	Do.
Norfolk & Western Railway Co.	Roanoke	Roanoke.

Consumers of fluorspar in electric-furnace steel plants in the United States—Con.

Name of consumer	Address of purchasing agent	Location of plant
Washington:		
Puget Sound Navy Yard.....	Bremerton.....	Bremerton.
Pacific Car & Foundry Co.....	Renton.....	Renton.
Washington Iron Works.....	Seattle.....	Seattle.
West Virginia:		
Duraloy Co.....	Pittsburgh, Pa.....	New Cumberland.
Ordnance Plant, Navy Department.....	South Charleston.....	South Charleston.
Wisconsin:		
Kinite Co.....	Milwaukee.....	Milwaukee.
Milwaukee Steel Foundry Co.....	do.....	Do.
Racine Steel Castings Co.....	Racine.....	Racine.

Consumers of fluorspar in the manufacture of ferro-alloys in the United States

Name of consumer	Address of purchasing agent	Location of plant
Iowa: Keokuk Electro-Metals Co.....	Keokuk.....	Keokuk.
New York:		
Electro Metallurgical Co.....	New York.....	Niagara Falls.
Vanadium Corporation of America.....	do.....	Do.
Pennsylvania:		
Vanadium Corporation of America.....	do.....	Bridgeville.
Molybdenum Corporation of America.....	Pittsburgh.....	Washington.
York Metal & Alloy Co.....	York.....	York.

Consumers of fluorspar in foundries and other metallurgical plants in the United States

Name of consumer	Address of purchasing agent	Location of plant
Alabama:		
American Cast Iron Pipe Co.....	Birmingham.....	Birmingham.
American Radiator Co.....	Buffalo, N. Y.....	Do.
Arkansas: Standard Brake Shoe & Foundry Co.....	Pine Bluff.....	Pine Bluff.
California:		
P. J. Fasullo Foundry.....	Hanford.....	Hanford.
Kinney Iron Works.....	Los Angeles.....	Los Angeles.
Barth Foundry & Machine Co.....	San Diego.....	San Diego.
Amalgamated Metals Corporation.....	San Francisco.....	San Francisco.
Colorado: C. S. Card Iron Works Co.....	Denver.....	Denver.
Connecticut:		
Crane Co.....	Bridgeport.....	Bridgeport.
North & Judd Manufacturing Co.....	New Britain.....	New Britain.
Waterbury Manufacturing Co.....	Waterbury.....	Waterbury.
Illinois:		
Apex Smelting Co.....	Chicago.....	Chicago.
Crane Co.....	do.....	Do.
Goldsmith Bros. Smelting & Refining Co.....	do.....	Do.
Great Western Smelting & Refining Co.....	do.....	Do.
Pyott Foundry Co.....	do.....	Do.
Aluminum Manufacturing Co.....	East Moline.....	East Moline.
Moore Bros. Co.....	Joliet.....	Joliet.
Walworth Co.....	Boston, Mass.....	Kewanee.
American Radiator Co.....	Buffalo, N. Y.....	Litchfield.
H. W. Clark Co.....	Mattoon.....	Mattoon.
Dayton Dowd Co.....	Quincy.....	Quincy.
Emerson-Brantingham Corporation.....	Rockford.....	Rockford.
Indiana:		
R W G Foundry Co.....	Anderson.....	Anderson.
McQuay-Norris Manufacturing Co.....	St. Louis, Mo.....	Connersville.
New York Central Railroad.....	Cleveland, Ohio.....	Elkhart.
Crescent Stove Works.....	Evansville.....	Evansville.
S. F. Bowser & Co.....	Fort Wayne.....	Fort Wayne.
American Foundry Co.....	Indianapolis.....	Indianapolis.
Indianapolis Castings Co.....	do.....	Do.
Globe Stove & Range Co.....	Kokomo.....	Kokomo.
Machinists Foundry Co.....	Muncie.....	Muncie.
Oliver Chilled Plow Works.....	South Bend.....	South Bend.
South Bend Foundry Co.....	do.....	Do.

*Consumers of fluorspar in foundries and other metallurgical plants in the
United States—Continued*

Name of consumer	Address of purchasing agent	Location of plant
Iowa: Maytag Co.....	Chicago, Ill.....	Newton.
Massachusetts:		
Richards Co.....	Boston.....	Malden.
Saco-Lowell Shops.....	Newton Upper Falls.....	Newton Upper Falls.
Gilbert & Barker Manufacturing Co.....	Springfield.....	Springfield.
Michigan:		
American Radiator Co.....	Buffalo, N. Y.....	Detroit.
Cadillac Motor Car Co.....	Detroit.....	Do.
Detroit Sanitary Manufacturing Co.....	do.....	Do.
Michigan Smelting & Refining Co.....	do.....	Do.
Packard Motor Car Co.....	do.....	Do.
D. J. Ryan Foundry Co.....	do.....	Ecorse.
Buick Motor Co.....	Flint.....	Flint.
Ford Motor Co.....	Detroit.....	Fordson.
Rempis & Gallmeyer Foundry Co.....	Grand Rapids.....	Grand Rapids.
Dodge Bros.....	Detroit.....	Hamtramck.
Campbell, Wyant & Cannon Foundry Co.....	Muskegon.....	Muskegon.
Piston Ring Co.....	do.....	Do.
Wilson Foundry & Machine Co.....	Pontiac.....	Pontiac.
Great Lakes Foundry Co.....	Port Huron.....	Port Huron.
Whitehead & Kales Co.....	Detroit.....	River Rouge.
Saginaw Products Co.....	Saginaw.....	Saginaw.
Sparta Foundry Co.....	Sparta.....	Sparta.
Ypsilanti Foundry Co.....	Ypsilanti.....	Ypsilanti.
Minnesota:		
American Brake Shoe & Foundry Co.....	Minneapolis.....	Minneapolis.
American Radiator Co.....	Buffalo, N. Y.....	St. Paul.
Missouri:		
St. Mary's Oil Engine Co.....	St. Charles.....	St. Charles.
McQuay-Norris Manufacturing Co.....	St. Louis.....	St. Louis.
New Jersey:		
American Radiator Co.....	Buffalo, N. Y.....	Bayonne.
Cox & Sons Co.....	Bridgeton.....	Bridgeton.
United States Metals Refining Co.....	Carteret.....	Carteret.
Moore Bros. Co.....	Elizabeth.....	Elizabeth.
Driver-Harris Co.....	Harrison.....	Harrison.
Eagle Iron & Brass Foundry Co.....	Passaic.....	Passaic.
New York:		
Fairbanks Co.....	Binghamton.....	Binghamton.
American Radiator Co.....	Buffalo.....	Black Rock (Buffalo).
Brooklyn Vault Light Co.....	Brooklyn.....	Brooklyn.
Cajan Foundry Co.....	do.....	Do.
Keystone Foundry Co.....	do.....	Do.
Niagara Falls Smelting & Refining Corporation.	Buffalo.....	Buffalo.
North Buffalo Hardware Co.....	do.....	Do.
Standard Foundry Co.....	do.....	Do.
Kennedy Valve Manufacturing Co.....	Elmira.....	Elmira.
Aluminum Co. of America.....	Pittsburgh, Pa.....	Massena, Niagara Falls.
General Electric Co.....	Schenectady.....	Schenectady.
Ohio:		
Era Steel Co.....	Bucyrus.....	Bucyrus.
G. A. Gray Co.....	Cincinnati.....	Cincinnati.
Consolidated Castings Co.....	Cleveland.....	Cleveland.
Euclid Foundry Co.....	do.....	Do.
Kilby Manufacturing Co.....	do.....	Do.
Standard Brass Foundry Co.....	do.....	Do.
Fox Furnace Co.....	Elyria.....	Elyria.
C. & G. Cooper Co.....	Mount Vernon.....	Mount Vernon.
Jackson Valve & Manufacturing Co.....	Portsmouth.....	Portsmouth.
Toledo Machine & Tool Co.....	Toledo.....	Toledo.
Pennsylvania:		
American Mond Nickel Co.....	Clearfield.....	Clearfield.
Hays Manufacturing Co.....	Erie.....	Erie.
Walworth Co.....	Boston, Mass.....	Greenburg.
Philadelphia Hardware & Malleable Iron Works.	Philadelphia.....	Philadelphia.
Frick Co.....	Waynesboro.....	Waynesboro.
Westinghouse Air Brake Co.....	Wilmerding.....	Wilmerding.
Rhode Island: Builders Iron Foundry.....	Providence.....	Providence.
South Dakota: Homestake Mining Co.....	Lead.....	Lead.
Tennessee:		
Aluminum Co. of America.....	Pittsburgh, Pa.....	Alcoa.
Crane Enamelware Co.....	Chattanooga.....	Chattanooga.
Washington: Salmon Bay Foundry Co.....	Seattle.....	Seattle.
West Virginia: International Nickel Co.....	New York, N. Y.....	Huntington.
Wisconsin:		
Kohler Co.....	Kohler.....	Kohler.
Nortmann Duffke Co.....	Milwaukee.....	Milwaukee.
Wisconsin Grey Iron Foundry Co.....	do.....	Do.
Liberty Foundry.....	Wauwatosa.....	Wauwatosa.

Consumers of fluorspar in the manufacture of glass in the United States

Name of consumer	Address of purchasing agent	Location of plant
Illinois:		
Inland Glass Co.....	Chicago.....	Clearing (Chicago).
Ball Bros. Glass Manufacturing Co.....	Muncie, Ind.....	Hillsboro.
Peltier Glass Co.....	Ottawa.....	Ottawa.
Indiana:		
Sneath Glass Co.....	Hartford City.....	Hartford City.
Kokomo Opalescent Glass Co.....	Kokomo.....	Kokomo.
Wells Glass Co.....	do.....	Do.
Canton Glass Co.....	Marion.....	Marion.
Macbeth-Evans Glass Co.....	Charleroi, Pa.....	Do.
Ball Bros. Glass Manufacturing Co.....	Muncie.....	Muncie.
New Jersey:		
Variety Glass Products Co.....	Clifton.....	Clifton.
Whitall Tatum Co.....	Philadelphia, Pa.....	Millville.
Kimble Glass Co.....	Vineland.....	Vineland.
New York:		
Dannenhoffer Glass Works.....	Brooklyn.....	Brooklyn.
Demuth Glass Manufacturing Co.....	do.....	Do.
Greiner Glass Co.....	Flushing.....	Do.
Williamsburg Flint Glass Co.....	New York.....	Do.
Gleason-Tiebout Glass Co.....	Brooklyn.....	Brooklyn, Maspeth.
Corning Glass Works.....	Corning.....	Corning.
Louis C. Tiffany Furnaces.....	Corona.....	Corona.
Gillinder Brothers.....	Port Jervis.....	Port Jervis.
Ohio:		
Imperial Glass Co.....	Bellaire.....	Bellaire.
Rodefer Glass Co.....	do.....	Do.
Cambridge Glass Co.....	Cambridge.....	Cambridge.
Lancaster Glass Co.....	Lancaster.....	Lancaster.
Advance Glass Co.....	Newark.....	Newark.
Oklahoma:		
Okla Glass Co.....	Ada.....	Ada.
A. K. Kerr & Co.....	Sand Springs.....	Sand Springs.
Kerr, Hubbard & Kelly.....	do.....	Do.
Pennsylvania:		
Cooperative Flint Glass Co.....	Beaver Falls.....	Beaver Falls.
Macbeth-Evans Glass Co.....	Charleroi.....	Charleroi.
Consolidated Lamp & Glass Co.....	Coraopolis.....	Coraopolis.
Jeannette Shade & Novelty Co.....	Jeannette.....	Jeannette.
Phoenix Glass Co.....	Pittsburgh.....	Monaca.
Point Marion Glass Novelty Co.....	Guyaux.....	Nilan.
Gill Glass Co.....	Philadelphia.....	Philadelphia.
L. J. House Convex Glass Co.....	Point Marion.....	Point Marion.
H. C. Fry Glass Co.....	Rochester.....	Rochester.
Gillinder & Sons.....	Philadelphia.....	Tacony (Philadelphia).
Hazel-Atlas Glass Co.....	Wheeling, W. Va.....	Washington.
Highland Glass Co.....	Washington.....	Do.
Texas: Ball Bros. Glass Manufacturing Co.....	Muncie, Ind.....	Wichita Falls.
West Virginia:		
Akro Agate Co.....	Clarksburg.....	Clarksburg.
Columbia Glass Co.....	Fairmont.....	Fairmont.
Monongah Glass Co.....	do.....	Do.
Jefferson Glass Co.....	Follansbee.....	Follansbee.
Beaumont Co.....	Morgantown.....	Morgantown.
New Martinsville Glass Co.....	New Martinsville.....	New Martinsville.
Paul Wissmach Glass Co.....	Paden City.....	Paden City.
Marion Glass Co.....	Shinnston.....	Shinnston.
Sinclair Glass Co.....	Van Voorhis.....	Van Voorhis.

Consumers of fluorspar in the manufacture of enamel, vitrolite, and glazes in the United States

Name of consumer	Address of purchasing agent	Location of plant
California:		
Smoot-Holman Co.....	Inglewood.....	Inglewood.
California Metal Enameling Co.....	Los Angeles.....	Los Angeles.
Washington Iron Works.....	do.....	Do.
Whiting-Mead Co.....	do.....	Do.
Standard Sanitary Manufacturing Co.....	Pittsburgh, Pa.....	Richmond.
Connecticut: New England Enameling Co.....	Middletown.....	Middletown.
Illinois:		
Cribben & Sexton Co.....	Chicago.....	Chicago.
Federal Electric Co.....	do.....	Do.
General Porcelain Enameling & Manufacturing Co.....	do.....	Do.
Theo. A. Kochs Co.....	do.....	Do.
Wolff Manufacturing Co.....	do.....	Do.
Chicago Vitreous Enamel Products Co.....	Cicero.....	Cicero.
Coonley Manufacturing Co.....	do.....	Do.
Crown Stove Works.....	Chicago.....	Do.
Benjamin Electric Manufacturing Co.....	Des Plaines.....	Des Plaines.
National Enameling & Stamping Co.....	Granite City.....	Granite City.
Sprague Sells Corporation.....	Hoopeston.....	Hoopeston.
Tiffany Enameled Brick Co.....	Momence.....	Momence.
Chicago Hardware & Foundry Co.....	North Chicago.....	North Chicago.
Indiana:		
Marietta Manufacturing Co.....	Indianapolis.....	Indianapolis.
Union Sanitary Works.....	Noblesville.....	Noblesville.
Columbian Enameling & Stamping Co.....	Terre Haute.....	Terre Haute.
Kentucky:		
Columbia Sanitary Manufacturing Co.....	Louisville.....	Louisville.
Standard Sanitary Manufacturing Co.....	Pittsburgh, Pa.....	Do.
Maryland:		
Baltimore Enamel & Novelty Co.....	Baltimore.....	Baltimore.
Jones Hollow Ware Co.....	do.....	Do.
Porcelain Enamel & Manufacturing Co.....	do.....	Do.
Standard Sanitary Manufacturing Co.....	Pittsburgh, Pa.....	Do.
A. Weiskittel & Co.....	Baltimore.....	Do.
Massachusetts: General Electric Co.....	Schenectady, N. Y.....	Lynn.
Michigan:		
A-B Stove Co.....	Battle Creek.....	Battle Creek.
Detroit-Michigan Stove Co.....	Detroit.....	Detroit.
Grand Rapids Refrigerator Co.....	Grand Rapids.....	Grand Rapids.
Michigan Enameling Works.....	Kalamazoo.....	Kalamazoo.
Minnesota: Seeger Refrigerator Co.....	St. Paul.....	St. Paul.
Missouri:		
Bridge & Beach Manufacturing Co.....	St. Louis.....	St. Louis.
Buck Stove & Range Co.....	do.....	Do.
New Jersey:		
Ingram-Richardson Corporation.....	Bayonne.....	Bayonne.
Central Stamping Co.....	Newark.....	Newark.
Kohler Co.....	Kohler, Wis.....	Trenton.
J. L. Mott Co.....	Trenton.....	Do.
Sneyd Enameled Brick Co.....	do.....	Do.
New York:		
Buffalo Pottery.....	Buffalo.....	Buffalo.
Republic Metal Ware Co.....	do.....	Do.
Lisk Manufacturing Co.....	Canandaigua.....	Canandaigua.
Vitreous Enameling & Stamping Co.....	New York.....	New York.
Pfaudler Co.....	Rochester.....	Rochester.
General Electric Co.....	Schenectady.....	Schenectady.
Robineau Pottery.....	Syracuse.....	Syracuse.
Lalanc & Grosjean Manufacturing Co.....	New York.....	Woodhaven.
Ohio:		
Bellaire Enamel Co.....	Bellaire.....	Bellaire.
Oxford Pottery Co.....	Cambridge.....	Cambridge.
Republic Stamping & Enameling Co.....	Canton.....	Canton.
Limberg Enameling Works.....	Cincinnati.....	Cincinnati.
American Stove Co.....	St. Louis, Mo.....	Cleveland.
Enamel Products Co.....	Cleveland.....	Do.
Perfection Stove Co.....	do.....	Do.
Vitreous Enameling Co.....	do.....	Do.
D. A. Ebinger Sanitary Manufacturing Co.....	Columbus.....	Columbus.
Beach Enameling Co.....	Coshocton.....	Coshocton.
Ferro Enameling Co.....	Cleveland.....	Cuyahoga Heights.
Pfaudler Co.....	Rochester, N. Y.....	Elyria.
Barnes Manufacturing Co.....	Mansfield.....	Mansfield.
Humphries Manufacturing Co.....	do.....	Do.
American Stamping & Enameling Co.....	Massillon.....	Massillon.
Belmont Stamping & Enameling Co.....	New Philadelphia.....	New Philadelphia.
Portsmouth Stove & Range Co.....	Portsmouth.....	Portsmouth.
National Sanitary Co.....	Salem.....	Salem.
Roseville Pottery Co.....	Zanesville.....	Zanesville.
S. A. Weller Co.....	do.....	Do.

Consumers of fluorspar in the manufacture of enamel, vitrolite, and glazes in the United States—Continued

Name of consumer	Address of purchasing agent	Location of plant
Pennsylvania:		
John Dunlap Co.....	Pittsburgh.....	Carnegie.
American Specialty Stamping Co.....	Johnstown.....	Johnstown.
Marietta Hollow Ware & Enameling Co.....	Marietta.....	Marietta.
United States Sanitary Manufacturing Co.....	Pittsburgh.....	Monaca.
Standard Sanitary Manufacturing Co.....	do.....	New Brighton, Pittsburgh.
Vitro Manufacturing Co.....	do.....	Pittsburgh.
Prizer-Painter Stove Co.....	Reading.....	Reading.
Richmond Radiator Co.....	Uniontown.....	Uniontown.
Iron City Sanitary Manufacturing Co.....	Pittsburgh.....	Zelienople.
Tennessee: Crane Enamelware Co.....	Chattanooga.....	Chattanooga.
West Virginia:		
Fletcher Enamel Co.....	Charleston.....	Dunbar.
Wheeling Sanitary Manufacturing Co.....	Wheeling.....	Elm Grove.
United States Stamping Co.....	Moundsville.....	Moundsville.
Vitrolite Co.....	Chicago, Ill.....	Parkersburg.
Wisconsin:		
Malleable Iron Range Co.....	Beaver Dam.....	Beaver Dam.
Kohler Co.....	Kohler.....	Kohler.
Geuder, Paeschke & Frey Co.....	Milwaukee.....	Milwaukee.
Rundle Manufacturing Co.....	do.....	Do.
Polar Ware Co.....	Sheboygan.....	Sheboygan.
Vollrath Co.....	do.....	Do.

Consumers of fluorspar in the manufacture of chemicals in the United States

Name of consumer	Address of purchasing agent	Location of plant
Delaware: General Chemical Co.....	New York, N. Y.....	Clayton.
Illinois: Aluminum Ore Co.....	Pittsburgh, Pa.....	East St. Louis.
Indiana: U. S. S. Lead Refinery.....	New York, N. Y.....	East Chicago.
Nebraska: American Smelting & Refining Co.....	do.....	Omaha.
New York: John C. Wiarda & Co.....	Brooklyn.....	Brooklyn.
Ohio: Harshaw Fuller & Goodwin Co.....	Cleveland.....	Cleveland.
Pennsylvania: General Chemical Co.....	New York, N. Y.....	Newell.

CONDITIONS IN FOREIGN COUNTRIES

CANADA ⁸

The renewed activity in the fluorspar industry in Canada, which was apparent in 1925, was not sustained in 1926. No shipments of fluorspar were reported from Canadian deposits during 1926. In the preceding 12 months production amounted to 3,886 short tons, valued at \$19,234 and consisted principally of shipments from the Rock Candy mine and mill at Lynch Creek, British Columbia.

Fluorspar importations continue to increase; in 1926 imports amounting to 9,968 tons, worth \$97,482, were shipped in from foreign countries. Customs' records showed 5,111 tons, appraised at \$60,458, imported into Canada in 1925.

SPAIN

As fluorspar is imported from Spain into the United States, a report on the fluorspar industry in Spain by Hester⁹ and another

⁸ Dominion Bureau Statistics, "Preliminary production of Canada during the calendar year 1926," Ottawa, 1927.

⁹ Hester E. J., assistant commercial attaché, American Embassy, Madrid, Spain, Mineral Production in Spain—Fluorspar: Report dated Jan. 22, 1927.

by Henry,¹⁰ which discusses the Berta mine, are of interest. The information concerning the Berta mine was obtained chiefly from representatives of the mine by Henry, who visited the mine and who states that from the viewpoint of a nontechnical observer the statements made by the representatives appear to be justified. A summary of the reports by Hester and Henry follows.

The consumption of fluorspar in Spain up to the present has been very small, and although it promises to increase it will probably not be sufficient to support even a single mining enterprise of much size for years to come. A few tons are used annually by the glass industry; the iron and steel industry at Sagunto now uses about 100 tons a month, and it is thought there is a potential demand from the copper industry of Huelva Province and from the iron and steel plants of Bilbao. At the best, demand is not likely to exceed a few hundred tons monthly for a long time.

Until sometime in 1923 the production of fluorspar was limited to the Province of Guipuzcoa, where two mines, the San Maximiliano and Brillante, located at Irun, were in operation. The San Maximiliano mine has been producing almost continuously since 1907; up to 1917 it had yielded more fluorspar than lead, but since 1917 lead has been the principal mineral (5,000 to 7,000 tons annually since 1920) and the production of fluorspar is distinctly a by-product.

The Brillante mine is worked mainly for lead, but **some fluorspar** is obtained as a by-product. The production of fluorspar from this mine ceased in 1919–20, whether through exhaustion of the deposits or through attention being confined to lead production is not known.

A quarry known as La Collada, located near Siero, Province of Oviedo, was opened in 1924. The entire output of this quarry in 1924 was exported, but the output for 1925 was consumed in steel and iron plants on the north coast of Spain.

The Berta mine, situated at Papiol, Province of Barcelona, which was developed some years ago in the hope that it would become a lead producer, was reopened during 1925 for the purpose of recovering fluorspar.

The Jorna mine, at Murelaga, Province of Vizcaya, is said to have produced a small quantity of fluorspar in 1926 which was sold for local metallurgical use. The capacity of the Jorna mine is reported to be 5 tons a day.

A number of other deposits are reported in Spain, especially in the Provinces of Huesca, Ciudad Real, and Córdoba. Most of these contain objectionable impurities and are geographically too remote for profitable exploitation. In the Province of Córdoba fluorspar appears as an accessory mineral associated with certain lodes in different places at Cerro Muriano, where it is possible to obtain small particles of fluorspar from old diggings. However, about 8 kilometers (5 miles) from Fuente Obejuna, and in the vicinity of Peñarroya larger deposits of green and violet fluorspar occur. As these deposits are exposed, their exploitation should be comparatively easy and profitable.

The Berta mine is situated in the Province of Barcelona at Papiol, about 12 miles distant from the port of Barcelona. The deposit,

¹⁰ Henry, F. A., American consul, Barcelona, Spain, "Fluorspar Deposits at Papiol, Near Barcelona, Spain"; Consular report dated Apr. 30, 1926.

which is in a hill, is developed by a number of drifts, and seemingly has been extensively stoped. A number of years ago the property was equipped and electrified at a cost of 4,000,000 pesetas,¹¹ but the mine was flooded and lead production was abandoned. During 1925 it was reopened in a small way for the purpose of extracting fluor-spar, of which there seems to be a very large quantity.

In the mine seven known veins, each about 2 meters (6.6 feet) thick, 600 meters (1,969 feet) long, and 200 meters (656 feet) deep, have been exploited and have been estimated to contain 5,000,000 tons of ore. The latest workings are reported to show veins of greater length and thickness, so that it is believed that the quantity of ore available is much greater than estimated. Six horizontal adits have been driven, allowing easy access to the veins, from which the ore is mined by picks and electric drills and is brought to the surface in hand-pushed cars on light rails. As the mine is wired, electric haulage can be had with a small additional expenditure. The mine is opened on several levels, and the total workings measure more than 3 miles in length. They average 3 meters (9.8 feet) in height and 2 meters (6.6 feet) in width.

The ore contains some lead, but the quantity varies greatly in different parts of the mine, ranging from traces to a considerable percentage. The largest lead bearing veins, however, are in the lower levels which are flooded with water. Usually a more or less clean separation of lead can be made by hand picking. Some ore is coarsely crushed and the lead and fluor-spar separated by washing.

The owners estimate that with the present installation from 5,000 to 10,000 tons of fluor-spar can be extracted monthly. The mill has a capacity of 150 tons per 8 hours, so that by working three shifts 450 tons per day can be crushed and concentrated.

About 50 men are now employed in the mine. Wages vary from 8 pesetas (\$1.19) for miners to 15 pesetas (\$2.23) for foremen per 8-hour day.

The fluor-spar found in the Berta mine is usually greenish, semi-transparent, and averages 94 to 98 per cent of calcium fluoride, 0.15 to 4 per cent of silica, and a very small amount of sulphur. It also carries small quantities of carbonate of lime and silicates of iron and aluminum. Analyses of two samples, made in Barcelona in September, 1925, showed the following:

	Green color	White-rose color
	<i>Per cent</i>	<i>Per cent</i>
Calcium fluoride.....	98.60	94.40
Silica.....	.15	3.20
Sulphur.....	.02	.04

The mine appears to be favorably situated with regard to transportation. The ore is hauled 1 to 2 miles by motor truck to the nearest railroad station, where it is loaded on cars and carried to

¹¹ The average rate of exchange in 1926, as compiled by the Federal Reserve Board, was 1 peseta equals 14.8959 cents, which conversion factor is used throughout this discussion. The value of the peseta has fluctuated, and the value in 1926 can not safely be applied to a former year.

the wharf. Total transportation costs from mine mouth to wharf are at present about 15 pesetas (\$2.23) per ton, but these could probably be lowered by a large output, particularly if the output justified the construction of a railway spur to the mine itself. Transportation to the United States appears to present few difficulties, as ample tonnage is always available for westbound cargo, which normally is very small. It is understood that freight offers of 16 pesetas (\$2.38) per ton have been made, and that possibly even a lower rate could be obtained.

The cost of production is reported to be about 35 pesetas (about \$5.21) per ton at the mine mouth, and c. i. f. costs at United States seaboard are estimated in the neighborhood of 66 to 70 pesetas (\$9.83 to \$10.43) a ton.

From the standpoint of the shipper development of trade with the United States would be desirable, as there is a shortage of westbound cargo, and the shipment of regular quantities of ore from Barcelona might make possible an opposite movement of some bulk cargo such as coal.

PRODUCTION, BY COUNTRIES

The following table was compiled by L. M. Jones, of the Bureau of Mines, from official sources so far as possible.

Production of fluorspar, 1922-1926, by countries, in metric tons

Country	1922	1923	1924	1925	1926
Australia:					
New South Wales.....			478		(1)
Queensland.....			1,894	4,295	2,348
Canada.....	4,085	126	69	3,525	
France.....	9,251	12,913	23,047	24,423	(1)
Germany: ²					
Bavaria.....	13,221	10,543	21,663	31,454	(1)
Prussia.....	8,630	10,810	13,078	24,101	(1)
Saxony.....	8,509	5,761	9,032	16,141	(1)
Great Britain.....	33,878	49,818	50,286	39,706	(1)
Italy.....	1,395	3,362	6,831	7,770	5,800
Japan.....	36				(1)
Mexico ³	500	500	500	500	500
Spain.....	392		4,474	2,436	(1)
Union of South Africa.....	(1)	10,975	10,192	4,883	(1)
United States.....	128,453	109,939	113,378	103,118	116,715

¹ Figures not available.

² In addition to the German states listed, fluorspar is produced in Baden and Thuringia, but data of output are not available.

³ Estimated annual output.

CRYOLITE

Cryolite occurs in commercial quantities and is mined at only one place—Iviglut, Greenland. Formerly two-thirds of the product was sold to the Pennsylvania Salt Co. and the other third went to Copenhagen, but at present these relative proportions are reversed. Of the cryolite shipped to the United States, the greater part is now used as a flux in the metallurgy of aluminum and for making opaque glass. In aluminum metallurgy in this country the mineral is being supplanted by artificial cryolite.

An article on the cryolite mine at Ivigtut has recently been published.¹² It discusses the discovery, exploitation, and mining of cryolite and describes the geology and mineralogy of the deposit.

The imports of cryolite into the United States in 1926, according to the Bureau of Foreign and Domestic Commerce, amounted to 7,599 long tons, valued at \$557,598, or \$73.38 a ton, compared with 9,844 long tons, valued at \$690,651, or \$70.16 a ton, in 1925.

¹² Gordon, S. G., "Mining cryolite in Greenland": Eng. and Min. Jour.-Press, vol. 121, Feb. 6, 1926, pp. 236-240.





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